Experimental Studies on Strength Properties of Concrete By Partial Replacement of Bottom Ash to Fine Aggregate And Fly Ash to Cement

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Abstract- *Concrete is an important construction material in the present world due to industrialization and urbanization. Concrete has become a basic need for every structure nowadays. The increasing population puts a lot of pressure on the civil engineer to develop a cost effective as well as an eco-friendly structure according to the need of the people. Concrete is a heterogeneous mixture of binding material (cement or lime), coarse aggregates, fine aggregates and water. In these components only cement is manufactured and both fine and coarse aggregate has been obtained naturally. Aggregates are the important constituents in concrete. At the same time the accumulation of industrial waste generated from various industries faces serious problems of handling and disposal all over the world. If the waste materials are found suitable in replacing the components of concrete, it can reduce the cost of construction as well as provide a safe method of disposal.*

Usage of artificial aggregates in construction is being studied for replacement of natural Aggregates in production of concrete. In many areas of developing world, good quality aggregates are very limited or practically not available and therefore it has become necessary to study alternative materials.

As there is large scale dumping of Fly ash and Bottom ash from the thermal power plant an investigation is carried out for M25 grade concrete to study the effect of strength with inclusion of fly ash and bottom ash. Bottom ash is part of the non-combustible residue of combustion in a furnace. Fly ash is used for replacement of cement by 20% as it gains strength in later stages and bottom ash is used for replacement for fine aggregates at 10%, 20%, 30%. In this study aspect such as compressive strength test, flexural strength test, and accelerated curing test is being studied. Accelerated curing test is carried out for the cubes to determine the strength of 28 days of curing in just 24 hours. Replacement material of fine aggregate i.e. bottom ash is procured from Raichur Thermal Power Station.

Keywords- Fly Ash, Bottom Ash, Compressive strength, flexural strength test, and accelerated curing test.

I. INTRODUCTION

Concrete is a material synonymous with strength and longevity. It has been emerged as the one of the dominant construction material for the need of infrastructure development in twenty first century. In addition to being durable, concrete also have high compressive load bearing capacity, and is therefore widely used in all types of structural systems easily prepared and fabricated from readily available constituents. The challenge for the civil engineering community in future is to realize projects in trending with the concept of sustainable development and this involves the use of high performance materials and products manufactured at reasonable cost with the lowest possible criteria's. Environmental impact energy is the main backbone of modern civilization of the world over, and the thermal power stations are the major power generating source of electric power, in the form of electricity. In India, over 70% of electricity generated in India is by combustion of fossil fuels, out of which nearly 61% is produced by coal-fired plants. This coal fired power plants produces approximately 1000's tons of ash per year. These ash produced are mostly disposed to the dry lands or ash ponds. 30% of it is used by the various engineering requirements that is for low technical applications such as in construction of fills and embankments, backfills, pavement base and sub base course. Bottom ash is a coarse granular and incombustible by product from coal burning furnaces. It's major compositions are silica, alumina and iron with small amounts of calcium, magnesium sulfate, etc. The appearance and particle size distribution of coal bottom ash is similar to that of river sand. Bottom ash based artificial lightweight aggregate offer potential for large scale utilization in the construction work.

II. LITERATUREREVIEW

P. RANAPRATAP (2016): the above mentioned author conducted the experiment on the effect of replacing fine aggregate with bottom ash in M20 grade of concrete. As we all know that in INDIA due to lot of construction the river sand is depleting day by day, it as reached the sacristy point. In this experiment the study of strength properties and economic study of the concrete by replacing sand with bottom ash in the concrete is done and also the partial replacement of crush sand and robo sand with bottom ash are used for the experimental study. The investigation of compressive strength of concrete is carried out for the concrete at 7days, 14dasy and for 28days by replacing bottom ash for 0%, 10%, 20% up to 60%. They selected the opc grade of concrete of concrete mainly to attain high early strength in the concrete.

PRADEEP G (2016): by the above paper titled "BOTTOM ASH AS A PARTIAL REPLACEMENT OF FIONE AGGREGATE IN ADDITIION WITH PPE" we got to know that the bottom ash can be replaced with fine aggregate. In this tudy the fine aggregate has been replaced to bottom ash along with polypropylene fibers in addition which is used to enchance the strength properties of concrete. The author studied the strength properties of concrete for M25 grade of concrete. The mix design was prepared for different proportion of 0%,10%,20% and 30% by replacing fine aggregate to bottom ash with additional of 05% of polypropylene fibre to the total weight of the cube. It was seen that the there was no degradation in strength properties of beam with bottom ash as replacement of fine aggregate when casted and tested for bean sixe of 1.5*0.25*0.15m under two point loading.

M BRINDHA (2016): the above mentioned author carried out the experimental stidies on the durability of cement motor by replacing bottom ash and green sand to fine aggregate. In this experiment the water cement rartion used was high that is 0.55 with the superplastizer of 2.5% to weight of thr cemet. The cement mix for 10%,20%,30% was calculated and casted and tested for compressive, splite tensile, water absorption, porosity was tested.

2.1 Conclusion: Based on the work of various researchers it was seen that bottom ash can be a suitable material for replacement of concrete mix. Following conclusions can be drawn. The compressive strength for 7, 28, 56 and 90 days was increased up to 15-20% replacement and after that compressive strengths were decreased for further more replacement. A marginal decrease was observed in the flexural strength up to 15-20% replacement level. A decrease in strength of concrete with the increase in levels of fine aggregate replacement by coal bottom ash is due to the replacement of the stronger material with the weaker material Workability of concrete decreases with the increase in percentage of Bottom ash, as it is more porous, therefore absorb more water than sand hence some super plasticizer can be used in increasing dose as percentage of bottom ash is increased.

III. MATERIALS

Cement: ordinary Portland cement of (Dalmia) 53 grade having specific gravity 3.15, fineness modulus 3.6% with initial setting 43 minutes and finial setting time 195 minutes is used for the investigation.

Fly Ash: Fly ash from the Raichur thermal power plant located in Raichur district, Karnataka state, India was used in the study having specific gravity of 2.2 is used.

Bottom Ash: Bottom ash which is a by-product of burning coal at thermal power plants has particles much coarser than the fly ash. It is a coarse, angular material of porous surface texture predominantly sand-sized. Bottom ash from the Raichur thermal power plant located in Raichur district, Karnataka state, India was used in the study having specific gravity of 2.65 is used.

Coarse aggregate: crushed stones of angular shaped aggregates with specific gravity 2.6, hard durable free from clay, were utilized for the study. Both 20mm and 12mm size aggregates were used with proportion of 80% and 20% respectively.

Fine aggregate: Manufactured Sand: M-Sand is used as fine aggregate. The bulk density of Manufactured sand was 1.75 kg/m3, specific gravity was found to be 2.73 . Moisture is trapped in between the particles which is good for concrete purposes. Higher concrete strength compared to river sand used for concreting.

IV. METHODOLOGY

Different concrete mix for replacements of 10%, 20%, 30% and 40% were prepared according to IS: 10262; 2000 standards.

Firstly cement, course aggregates, fine aggregates, fly ash, bottom ash were weighed according to the mix design and dry mixed mechanically until uniform colour was achieved. Then the water(potable water) was added according to the proportion until homogeneous mixture was obtained. The homogeneous mixture was poured into metallic tray and immediately slum was checked before the concrete was placed in different moulds. If the slump value was less than the

desirable value then the admixture of 0.1% to 0.5% of total cementitious materials was added until desirable slump value was obtained.

Cubes and beams of size 150mmX150mmX150mm, 100mmX100mmX500mm respectively, were used for casting. The cubes were cleaned thoroughly with a waste cloth and oil was applied to its surface. Then the concrete was filled in the moulds in three layers and each layer was compacted with 25 number of blows using tamping rod. Then the surface leveled and extra concrete was removed using travel. The moulds were kept on a plane and leveled surface for 24 hours and the cubes were removed from the mould and kept for curing. For the study 45 number of cubes and 15 beams specimen were casted, tested and results were obtained.

V. EXPERIMENTALSTUDIES

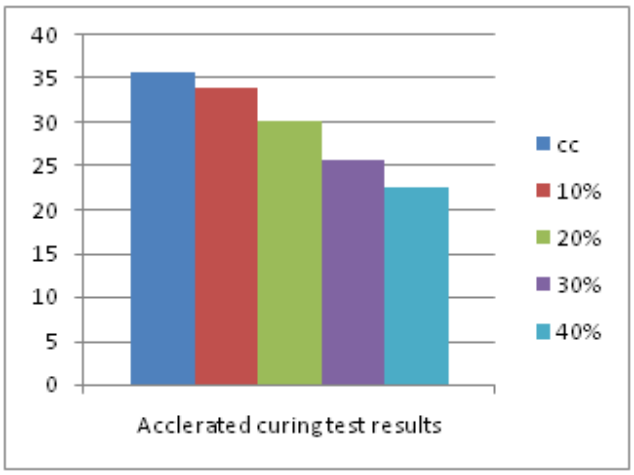
In the present work M25, grade of concrete is considered for the experimental investigation. Fine aggregate was practically replaced with 10%, 20%, 30%, 40% percentage of bottom ash and fly of 20% was replaced with cement. Comparative result of compressive strength, flexural strength and accelerated curing test of conventional concrete cube and bottom ash added concrete cube are reported.

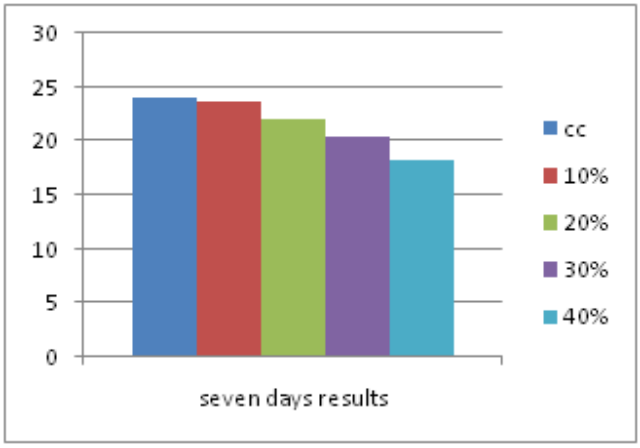
Constant parameters:

Grade of concrete: M25. Fly ash:20%
Size of specimen: 150mm×150mm×150mm
Variable parameters:
Bottom ash: fine aggregate is replaced with bottom ash in different proportion 10%, 20%, 30%, 40%.
Admixture: 0.1% to 0.5% of total quantity of cementations materials.
Curing period: 7days and 28days.

4.1 COMPRESSIVE STRENGTH:

The specimen of standard cube of (150 mm x150 mm x 150 mm) was used to determine the compressive strength of concrete. Three specimens were tested for 7 and 28 days with varying proportion of bottom-ash replacement. The constituents were weighed and the materials were mixed in a mixer. The mixes were compacted with the help of tamping rod. The specimens were de-molded after 24h, cured in water for 7 and 28 days and then tested for its compressive strength as per Indian Standards. The compressive strength test on cubes in the CTM machine was conducted.





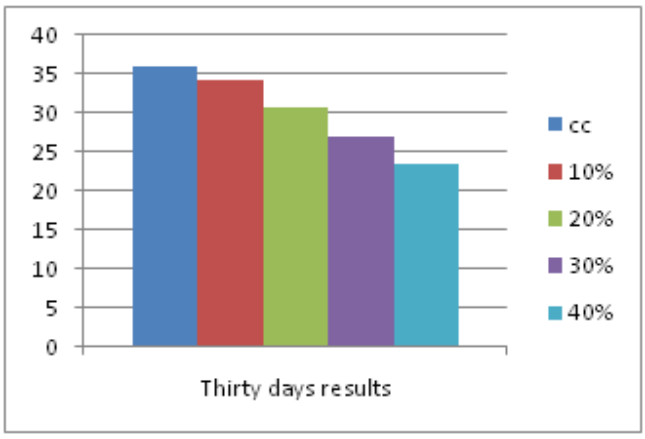


Table-3: Compressive Strength for M25grade

Age	Conventional concrete (N/mm^2)	10% bottom ash (N/mm^2)	20% bottom ash (N/mm^2)	30% bottom ash (N/mm^2)	40% bottom ash (N/mm^2)
7 days	24.1	23.6	21.96	20.5	18.3
28 days	36	34.2	30.8	27.1	23.4
ACT	35.7	33.9	30.1	25.8	22.5

FLEXURAL STRENGTH OFBEAM

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an un-reinforced concrete beam or slab to resist failure in bending. It is measured by loading 6 x 6-inch (150 x 150 mm) concrete beams with a span length of at least three times the depth

.Table-4: Flexural Strength Of Beam

Percentage of replacement of bottom ash	Test result In N/mm^2
Conventional concrete	4.1
10%	3.9
20%	3.5
30%	2.9
40%	2.1

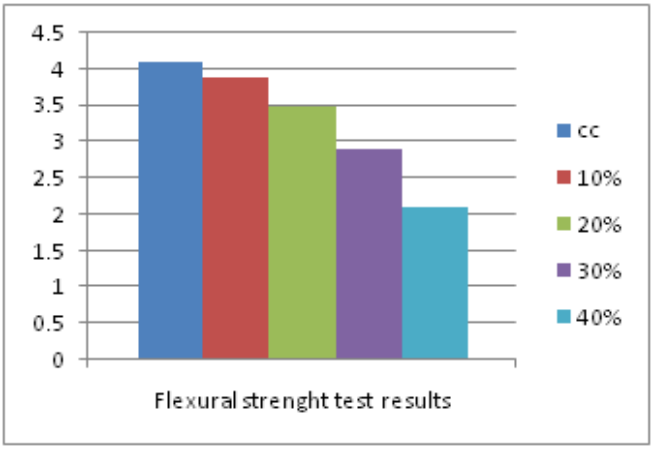


Table-1: The chemical composition of cement, flyash and bottom ash.

Content(%	Cement	Bottom ash	Fly ash
SiO_2	20.5	57.03	59.00
Al_2O_3	4.0	22.86	21.00
Fe_2O_3	4.02	7.05	3.70
K_2O	0.8	0.3	0.90
CaO	64.0	1.03	6.90
TiO_2	-	0.17	-
SO_3	1.8	6.15	1.00
MgO	1.2	0.85	1.40
Na_2O	-	4.29	-

Table 2 the svieanalysos of bottom ash

Sieve size	Materials retained on each sieve in	Cumulative mass in grams	Cumulative % mass retained	% passing
4.75mm	4.9	4.9	0.49	99.51
2.36mm	22.2	27.1	2.71	97.29
1.18mm	34.2	61.3	6.13	93.87
600µ	67.5	128.8	12.8	87.12
300µ	205.3	334.1	33.41	66.59
150µ	481.5	815.6	81.56	18.44
Pan	184.4	1000	100	0

VI. CONCLUSION

From the results of 7 days, 30days and accelerated curing test it can be concluded that the Bottom Ash can be used as a replacement for fine aggregate. The results prove that the replacement of fine aggregate by Bottom ash up to 30% and fly ash up to 20% with cement can be replaced. Bottom Ash induces higher compressive strength. Thus the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced. By keeping in mind the acute shortage of river sand, heavy short coming on quality of river sand, high cost, greater impact on road damages and environmental effects. Thus the construction industry shall start using the bottom-ash to full extent as an alternative and reduce the impacts on environment by not using river sand. The major drawback of bottom ash is its production, because as the study says when the pure coal is burnt in the power plant the residue obtained consists of 20% of bottom ash and 80% of fly ash.

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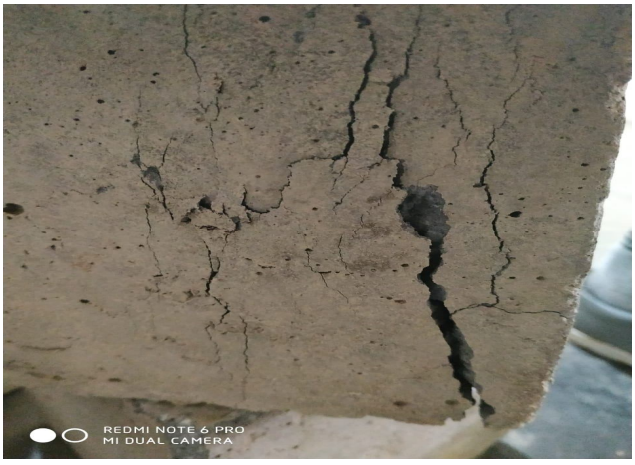

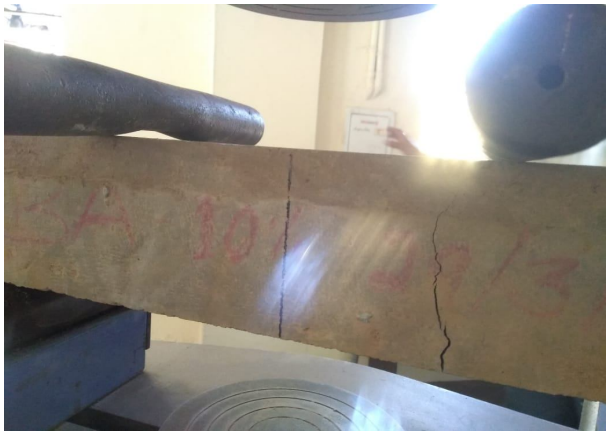


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